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| Product name | Description | Version |
|---|---|---|
| MC-1513-G | Standalone multiple GNSS module | 1.1 |



# 1   Introduction

LOCOSYS MC-1513-G is a complete standalone GNSS module. The module can simultaneously acquire and track multiple satellite constellations that include GPS, GLONASS, GALILEO, QZSS and SBAS. It features low power and small form factor. Besides, it can provide you with superior sensitivity and performance even in urban canyon and dense foliage environment.

This module supports hybrid ephemeris prediction to achieve faster cold start. One is self-generated ephemeris prediction (called EASY) that is no need of both network assistance and host CPU's intervention. This is valid for up to 3 days and updates automatically from time to time when GNSS module is powered on and satellites are available. The other is server-generated ephemeris prediction (called EPO) that gets from an internet server. This is valid for up to 14 days. Both ephemeris predictions are stored in the on-board flash memory and perform a cold start time less than 15 seconds.

# 2   Features

- MediaTek high sensitivity solution
- Support GPS, GLONASS, GALILEO and QZSS
- Capable of SBAS (WAAS, EGNOS, MSAS, GAGAN)
- Support 99-channel GNSS
- Ultra low power consumption
- Fast TTFF at low signal level
- Built-in 12 multi-tone active interference canceller
- Free hybrid ephemeris prediction to achieve faster cold start
- Built-in data logger
- Built-in DC/DC converter to save power
- Up to 10 Hz update rate
- ±11ns high accuracy time pulse (1PPS)
- Indoor and outdoor multi-path detection and compensation
- Support both UART and I2C interface
- Small form factor 15 x 13 x 2.2 mm
- SMD type with stamp holes; RoHS compliant

# 3   Application

- Personal positioning and navigation
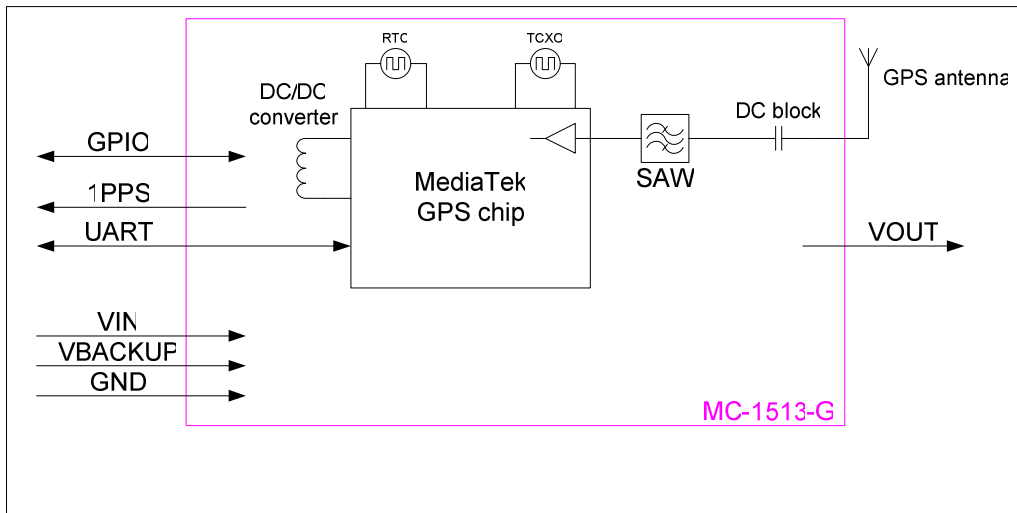- Automotive navigation
- Marine navigation

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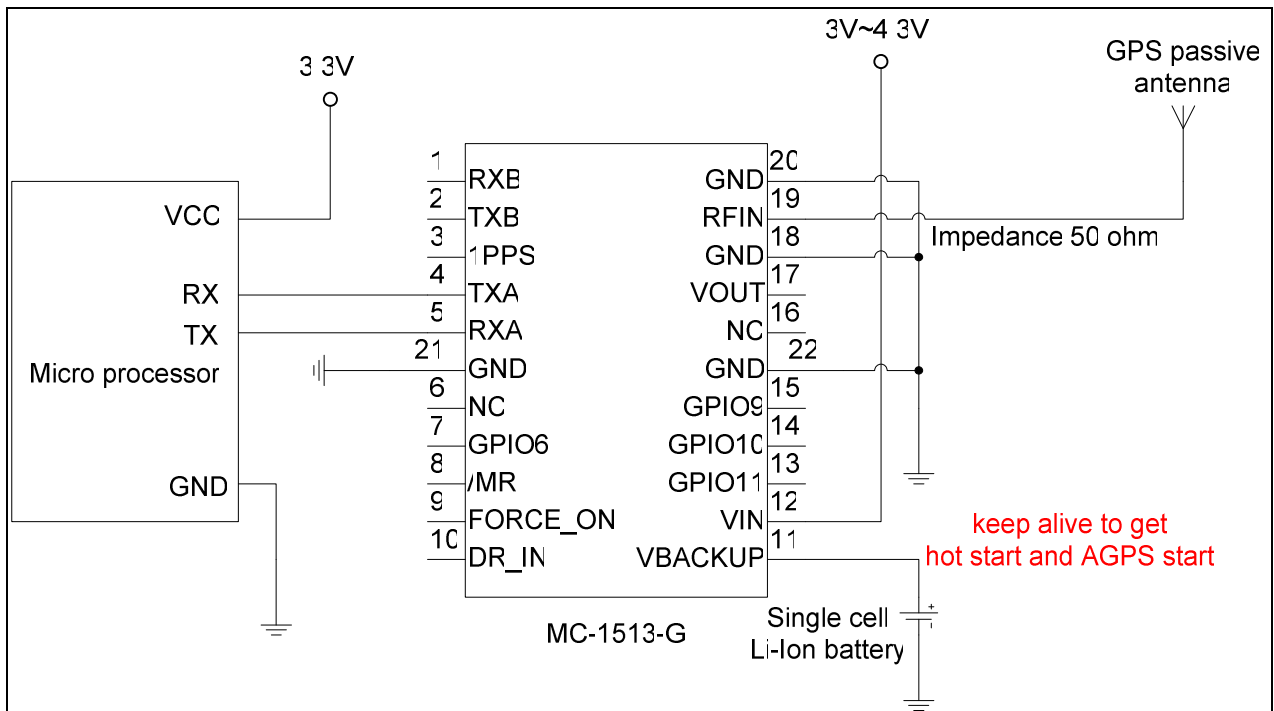
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Fig 3-1 System block diagram.

Fig 3-2 Typical application circuit that uses a passive antenna.

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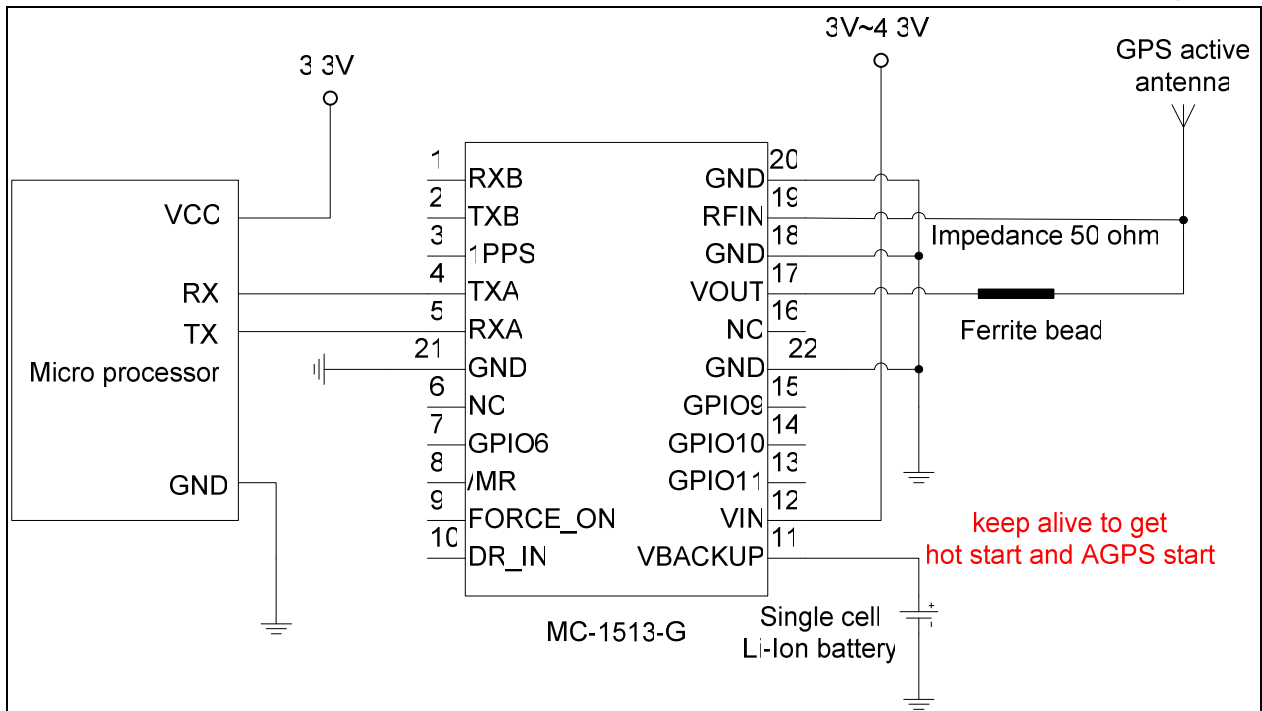📠 886-2-8698-3699
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Fig 3-3 Typical application circuit that uses an active antenna.
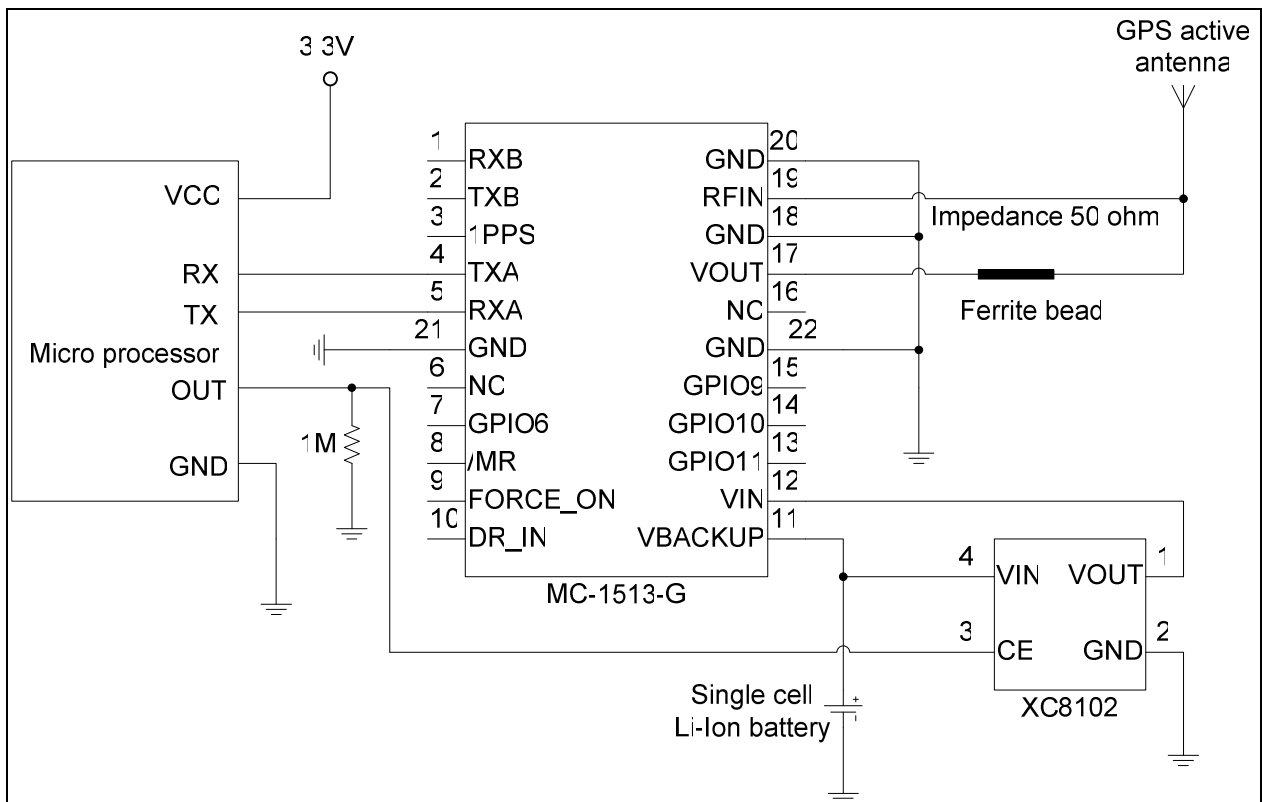


Fig 3-4 Typical application circuit that directly uses a Li-Ion battery as power source to save power.
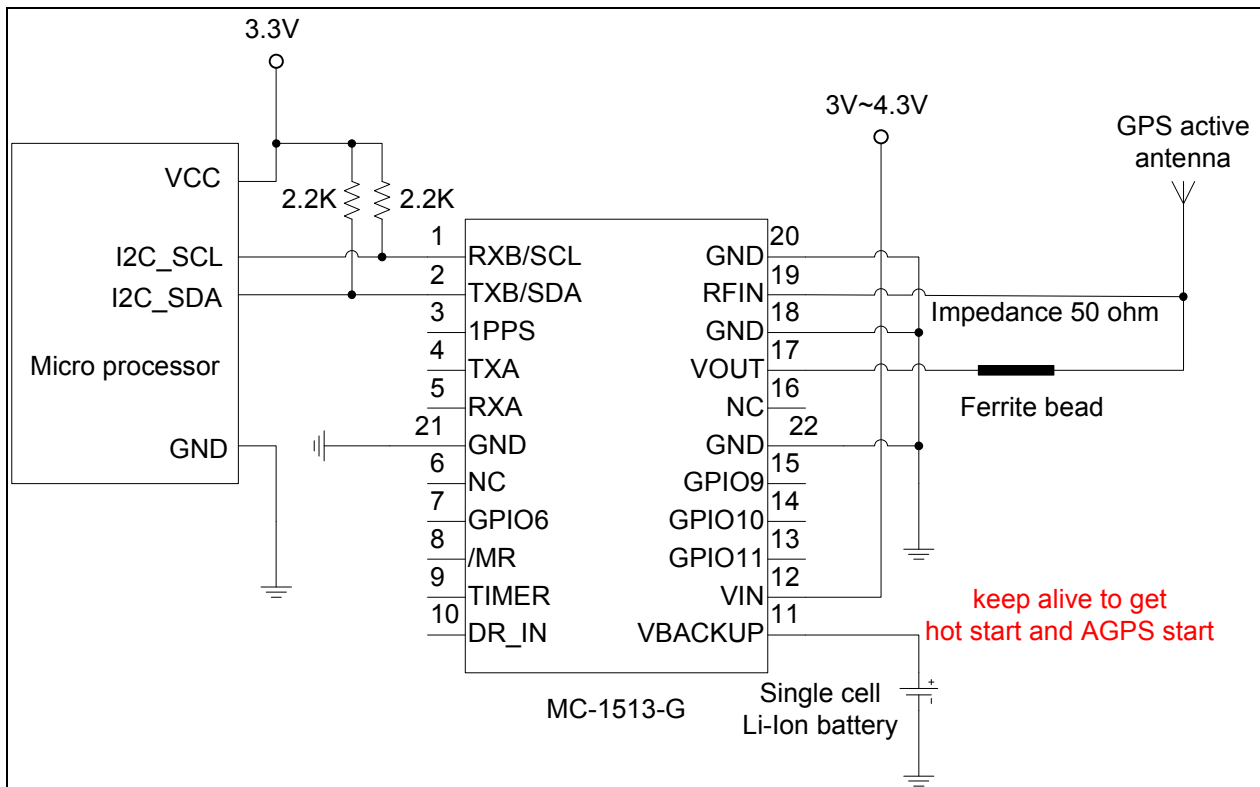
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Fig 3-5 Use I2C interface to communicate with MC-1513-G.

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# 4 GNSS receiver

| Chip | MediaTek MT3333 | |
|---|---|---|
| Frequency | GPS, GALILEO, QZSS: L1 1575.42MHz, C/A code | |
| | GLONASS: L1 1598.0625MHz ~ 1605.375MHz, C/A code | |
| Channels | Support 99 channels (33 Tracking, 99 Acquisition) | |
| Update rate | 1Hz default, up to 10Hz | |
| Sensitivity | Tracking | -161dBm, up to -165dBm (with external LNA) |
| | Cold start | -142.5dBm, up to -148dBm (with external LNA) |
| Acquisition Time | Hot start (Open Sky) | 1s (typical) |
| | Hot start (Indoor) | < 30s (typical) |
| | Cold Start (Open Sky) | 33s (typical) without AGPS |
| | | < 15s (typical) with AGPS (hybrid ephemeris prediction) |
| Position Accuracy | Autonomous | 3m (2D RMS). |
| | SBAS | 2.5m (depends on accuracy of correction data). |
| Max. Altitude | < 18,000 m, up to 50,000m by request | |
| Max. Velocity | < 515 m/s | |
| Protocol Support | NMEA 0183 ver 4.10 | 9600 bps[1], 8 data bits, no parity, 1 stop bits (default) |
| | | 1Hz: GGA, GLL, GSA, GSV, RMC, VTG |

Note 1: Both baud rate and output message rate are configurable to be factory default.

# 5 Software interface
## 5.1 NMEA output message

*Table 5.1-1 NMEA output message*

| NMEA record | Description |
|---|---|
| GGA | Global positioning system fixed data |
| GLL | Geographic position - latitude/longitude |
| GSA | GNSS DOP and active satellites |
| GSV | GNSS satellites in view |
| RMC | Recommended minimum specific GNSS data |
| VTG | Course over ground and ground speed |

● **GGA--- Global Positioning System Fixed Data**

Table 5.1-2 contains the values for the following example:

$GPGGA,183015.000,2503.7123,N,12138.7446,E,2,16,0.68,123.2,M,15.3,M,0000,0000*66

*Table5.1- 2* GGA Data Format

| Name | Example | Units | Description |
|---|---|---|---|

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| | | | |
|---|---|---|---|
| Message ID | $GPGGA | | GGA protocol header |
| UTC Time | 183015.000 | | hhmmss.sss |
| Latitude | 2503.7123 | | ddmm.mmmm |
| N/S indicator | N | | N=north or S=south |
| Longitude | 12138.7446 | | dddmm.mmmm |
| E/W Indicator | E | | E=east or W=west |
| Position Fix Indicator | 2 | | See Table 5.1-3 |
| Satellites Used | 16 | | Range 0 to 33 |
| HDOP | 0.68 | | Horizontal Dilution of Precision |
| MSL Altitude | 123.2 | mters | |
| Units | M | mters | |
| Geoid Separation | 15.3 | mters | |
| Units | M | mters | |
| Age of Diff. Corr. | 0000 | second | Null fields when DGPS is not used |
| Diff. Ref. Station ID | 0000 | | |
| Checksum | *66 | | |
| <CR> <LF> | | | End of message termination |

*Table 5.1-3* Position Fix Indicators

| Value | Description |
|---|---|
| 0 | Fix not available or invalid |
| 1 | GPS SPS Mode, fix valid |
| 2 | Differential GPS, SPS Mode, fix valid |
| 3-5 | Not supported |
| 6 | Dead Reckoning Mode, fix valid |

● **GLL--- Geographic Position – Latitude/Longitude**

Table 5.1-4 contains the values for the following example:

$GPGLL,2503.7123,N,12138.7446,E,183015.000,A,D*59

*Table 5.1-4* GLL Data Format

| **Name** | **Example** | **Units** | **Description** |
|---|---|---|---|
| Message ID | $GPGLL | | GLL protocol header |
| Latitude | 2503.7123 | | ddmm.mmmm |
| N/S indicator | N | | N=north or S=south |
| Longitude | 12138.7446 | | dddmm.mmmm |
| E/W indicator | E | | E=east or W=west |
| UTC Time | 183015.000 | | hhmmss.sss |

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| | | | |
|---|---|---|---|
| Status | A | | A=data valid or V=data not valid |
| Mode | D | | A=autonomous, D=DGPS, E=DR, N=Data not valid, R=Coarse Position, S=Simulator |
| Checksum | *59 | | |
| <CR> <LF> | | | End of message termination |

● **GSA---GNSS DOP and Active Satellites**

Table 5.1-5 contains the values for the following example:

$GNGSA,A,3,18,193,21,09,12,22,27,15,25,14,,,1.44,0.68,1.27*2F

$GNGSA,A,3,76,72,77,75,66,65,,,,,,,1.44,0.68,1.27*12

*Table 5.1-5* GSA Data Format

| Name | Example | Units | Description |
|---|---|---|---|
| Message ID | $GNGSA | | GSA protocol header |
| Mode 1 | A | | See Table 5.1-6 |
| Mode 2 | 3 | | See Table 5.1-7 |
| ID of satellite used | 18 | | Sv on Channel 1 |
| ID of satellite used | 193 | | Sv on Channel 2 |
| …. | | | …. |
| ID of satellite used | | | Sv on Channel N |
| PDOP | 1.44 | | Position Dilution of Precision |
| HDOP | 0.68 | | Horizontal Dilution of Precision |
| VDOP | 1.27 | | Vertical Dilution of Precision |
| Checksum | *2F | | |
| <CR> <LF> | | | End of message termination |

*Table 5.1-6 Mode 1*

| Value | Description |
|---|---|
| M | Manual- forced to operate in 2D or 3D mode |
| A | Automatic-allowed to automatically switch 2D/3D |

*Table 5.1-7 Mode 2*

| Value | Description |
|---|---|
| 1 | Fix not available |
| 2 | 2D |
| 3 | 3D |

● **GSV---GNSS Satellites in View**

Table 5.1-8 contains the values for the following example:

$GPGSV,3,1,11,18,67,344,48,09,55,031,50,42,54,142,40,193,47,174,45*4D

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$GPGSV,3,2,11,21,44,219,46,27,39,035,48,12,34,131,44,15,30,057,46*76

$GPGSV,3,3,11,22,27,319,47,14,22,285,42,25,19,171,40*44

$GLGSV,2,1,07,76,71,201,44,65,57,041,40,75,48,028,39,72,27,108,39*68

$GLGSV,2,2,07,66,25,333,43,77,17,207,37,81,02,280,29*5C

*Table 5.1-8* GSV Data Format

| Name | Example | Units | Description |
|---|---|---|---|
| Message ID | $GPGSV | | GSV protocol header (GPGSV and GLGSV) |
| Total number of messages[1] | 3 | | Range 1 to 6 |
| Message number[1] | 1 | | Range 1 to 6 |
| Satellites in view | 11 | | |
| Satellite ID | 18 | | Channel 1 (Range 01 to 196) |
| Elevation | 67 | degrees | Channel 1 (Range 00 to 90) |
| Azimuth | 344 | degrees | Channel 1 (Range 000 to 359) |
| SNR (C/No) | 48 | dB-Hz | Channel 1 (Range 00 to 99, null when not tracking) |
| Satellite ID | 09 | | Channel 4 (Range 01 to 196) |
| Elevation | 55 | degrees | Channel 4 (Range 00 to 90) |
| Azimuth | 031 | degrees | Channel 4 (Range 000 to 359) |
| SNR (C/No) | 50 | dB-Hz | Channel 4 (Range 00 to 99, null when not tracking) |
| Checksum | *4D | | |
| <CR> <LF> | | | End of message termination |

1. Depending on the number of satellites tracked multiple messages of GSV data may be required.


● **RMC---Recommended Minimum Specific GNSS Data**

Table 5.1-9 contains the values for the following example:

$GNRMC,183015.000,A,2503.7123,N,12138.7446,E,0.01,34.92,270812,,,D*43

*Table 5.1-9* RMC Data Format

| Name | Example | Units | Description |
|---|---|---|---|
| Message ID | $GNRMC | | RMC protocol header (GNRMC or GPRMC) |
| UTC Time | 183015.000 | | hhmmss.sss |
| Status | A | | A=data valid or V=data not valid |
| Latitude | 2503.7123 | | ddmm.mmmm |
| N/S Indicator | N | | N=north or S=south |
| Longitude | 12138.7446 | | dddmm.mmmm |
| E/W Indicator | E | | E=east or W=west |
| Speed over ground | 0.01 | knots | True |
| Course over ground | 34.92 | degrees | |
| Date | 270812 | | ddmmyy |

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| | | | |
|---|---|---|---|
| Magnetic variation | | degrees | |
| Variation sense | | | E=east or W=west (Not shown) |
| Mode | D | | A=autonomous, D=DGPS, E=DR, N=Data not valid, R=Coarse Position, S=Simulator |
| Checksum | *43 | | |
| <CR> <LF> | | | End of message termination |

- **VTG---Course Over Ground and Ground Speed**

Table 5.1-10 contains the values for the following example:

$GPVTG,34.92,T,,M,0.01,N,0.02,K,D*07

*Table 5.1-10* VTG Data Format

| Name | Example | Units | Description |
|---|---|---|---|
| Message ID | $GPVTG | | VTG protocol header |
| Course over ground | 34.92 | degrees | Measured heading |
| Reference | T | | True |
| Course over ground | | degrees | Measured heading |
| Reference | M | | Magnetic |
| Speed over ground | 0.01 | knots | Measured speed |
| Units | N | | Knots |
| Speed over ground | 0.02 | km/hr | Measured speed |
| Units | K | | Kilometer per hour |
| Mode | D | | A=autonomous, D=DGPS, E=DR, N=Data not valid, R=Coarse Position, S=Simulator |
| Checksum | *07 | | |
| <CR> <LF> | | | End of message termination |

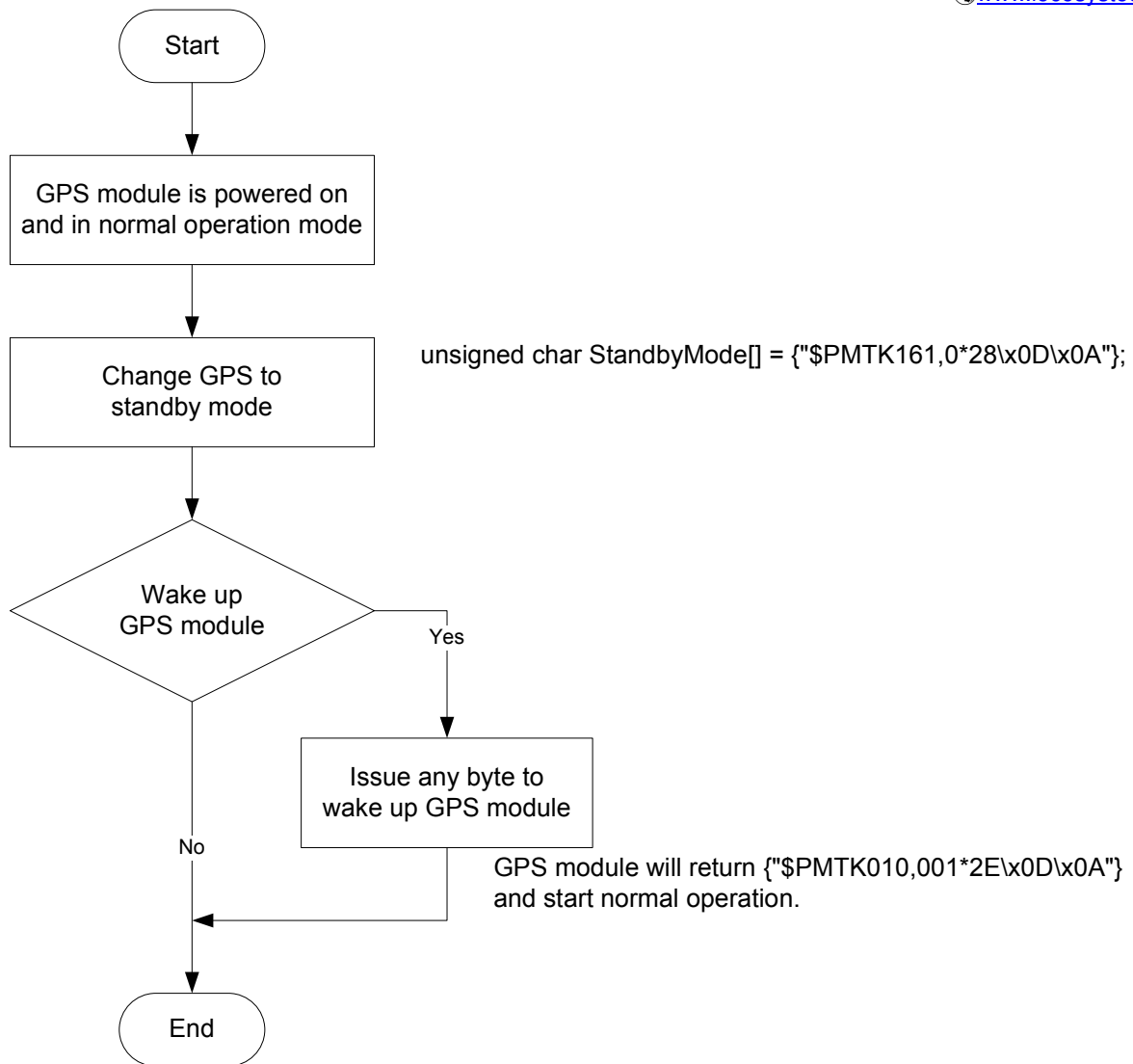## 5.2 Proprietary NMEA input/output message

Please refer to MTK proprietary message.

## 5.3 Examples to configure the power mode of GNSS module

The GNSS module supports different power modes that user can configure by issuing software commands.
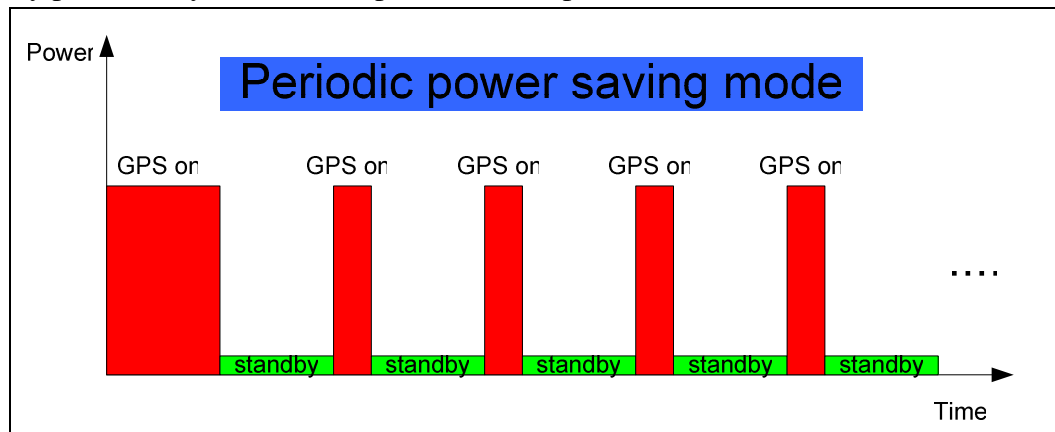
### 5.3.1 Standby mode

User can issue software command to make GNSS module go into standby mode that consumes less than 500uA current. GNSS module will be awaked when receiving any byte. The following flow chart is an example to make GNSS module go into standby mode and then wake up.
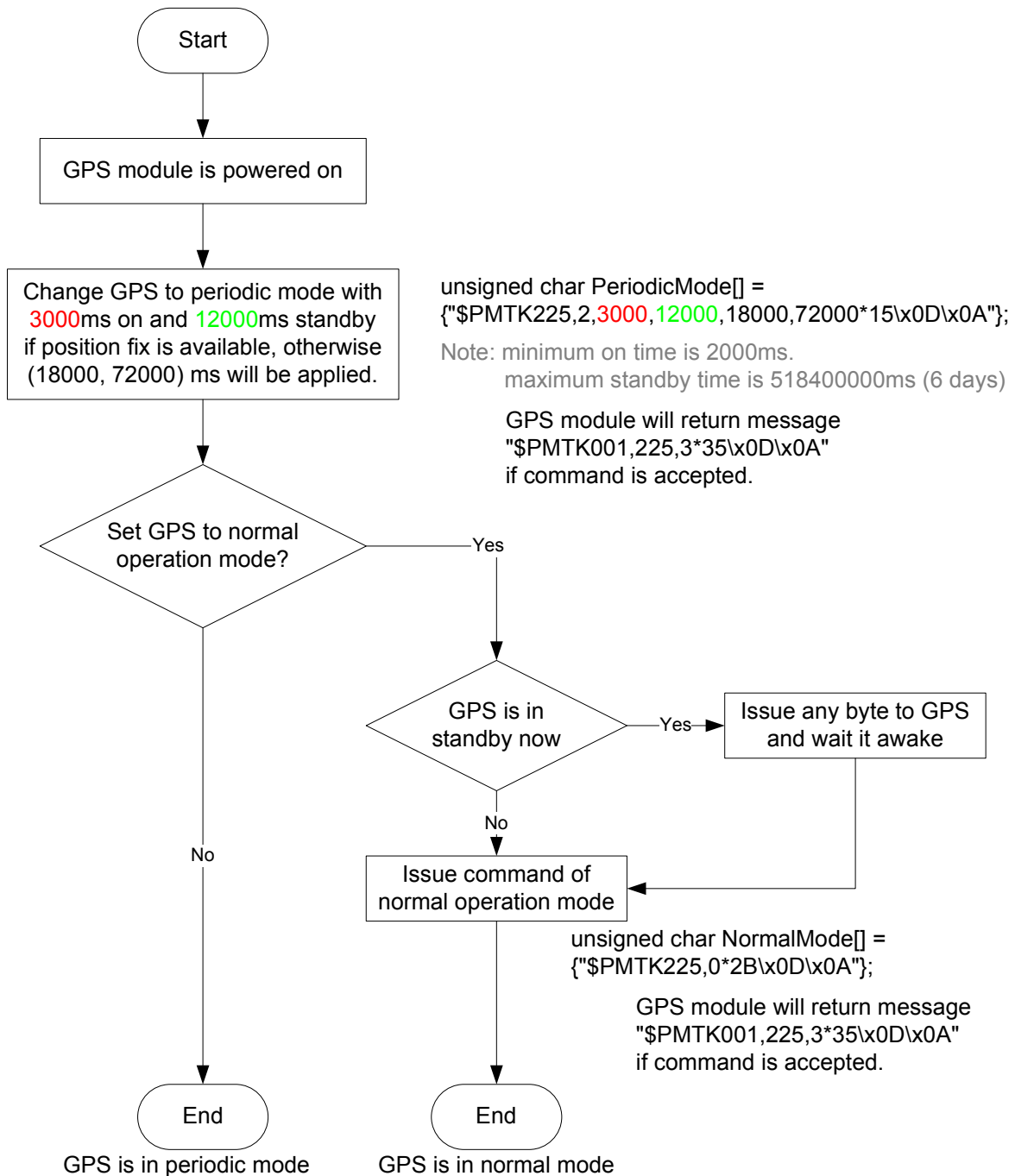
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```
        ┌──────────┐
        │  Start   │
        └────┬─────┘
             │
             ▼
   ┌──────────────────────┐
   │ GPS module is powered on │
   │ and in normal operation mode │
   └──────────┬───────────┘
              │
              ▼
   ┌──────────────────┐      unsigned char StandbyMode[] = {"$PMTK161,0*28\x0D\x0A"};
   │  Change GPS to    │
   │  standby mode     │
   └────────┬─────────┘
            │
            ▼
         ◇ Wake up
           GPS module ◇ ── Yes ──┐
            │                     │
            No                    ▼
            │          ┌──────────────────┐
            │          │ Issue any byte to │
            │          │ wake up GPS module │
            │          └────────┬─────────┘
            │                   │     GPS module will return {"$PMTK010,001*2E\x0D\x0A"}
            │◄──────────────────┘     and start normal operation.
            ▼
        ┌──────────┐
        │   End    │
        └──────────┘
```

### 5.3.2 Periodic mode

When GNSS module is commanded to periodic mode, it will be in operation and standby periodically. Its status of power consumption is as below chart.



The following flow chart is an example to make GNSS module go into periodic mode

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and then back to normal operation mode.

```
                    ┌─────────────┐
                    │    Start    │
                    └──────┬──────┘
                           ▼
          ┌────────────────────────────────┐
          │   GPS module is powered on      │
          └───────────────┬────────────────┘
                          ▼
  ┌──────────────────────────────────────┐
  │ Change GPS to periodic mode with      │
  │ 3000ms on and 12000ms standby         │
  │ if position fix is available, otherwise│
  │ (18000, 72000) ms will be applied.    │
  └──────────────────────────────────────┘
```

unsigned char PeriodicMode[] =
{"$PMTK225,2,3000,12000,18000,72000*15\x0D\x0A"};

Note: minimum on time is 2000ms.
　　　maximum standby time is 518400000ms (6 days)

GPS module will return message
"$PMTK001,225,3*35\x0D\x0A"
if command is accepted.

Set GPS to normal operation mode? —— Yes

GPS is in standby now —— Yes —— Issue any byte to GPS and wait it awake

No

Issue command of normal operation mode

unsigned char NormalMode[] =
{"$PMTK225,0*2B\x0D\x0A"};

GPS module will return message
"$PMTK001,225,3*35\x0D\x0A"
if command is accepted.

No

End — GPS is in periodic mode

End — GPS is in normal mode

## 5.3.3 AlwaysLocate<sup>TM</sup> mode

AlwaysLocate[TM] is an intelligent controller of periodic mode. Depending on the environment and motion conditions, GNSS module can adaptively adjust working/standby time to achieve balance of positioning accuracy and power consumption. In this mode, the host CPU does not need to control GNSS module until the host CPU needs the GNSS position data. The following flow chart is an example to make GNSS module go into AlwaysLocate[Tm] mode and then back to normal operation mode.

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Note: AlwaysLocate$^{TM}$ is a trade mark of MTK.

```
┌─────────┐
│  Start  │
└─────────┘
     │
     ▼
┌──────────────────────┐
│ GPS module is powered on │
└──────────────────────┘
     │
     ▼
┌──────────────────────┐
│  Change GPS to       │◄─────────────────── Yes
│  AlwaysLocate mode   │
└──────────────────────┘
```

unsigned char AlwaysLocateMode[] =
{"$PMTK225,8*23\x0D\x0A"};

GPS module will return message
"$PMTK001,225,3*35\x0D\x0A"
if command is accepted.

```
        ◇ Request a GPS position data ◇──── Yes ──► ┌──────────────────────┐
       No│          No                               │ Issue any byte to get │
         │                                            │ GPS position data     │
         │                                            └──────────────────────┘
         ▼                                                       │
    ◇ Set GPS to normal                                          ▼
      operation mode? ◇                              ◇ Change GPS back to
            │                                          AlwaysLocate mode ◇
           Yes                                              No│
            ▼                                                 │
┌──────────────────────┐                                     ▼
│ Issue any byte to GPS │──────────────────► ┌──────────────────────┐
│ and wait it awake     │                     │ Set GPS to normal    │
└──────────────────────┘                     │ operation mode       │
                                              └──────────────────────┘
```

unsigned char NormalMode[] =
{"$PMTK225,0*2B\x0D\x0A"};

```
┌─────────┐
│   End   │
└─────────┘
```

GPS is in normal mode

## 5.4 Data logger

The GNSS module has internal flash memory for logging GNSS data. The configurations

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include time interval, distance, speed, logging mode, and … etc. For more information, please contact us.

## 5.5 Examples to configure the update rate of GNSS module

The GNSS module supports up to 10Hz update rate that user can configure by issuing software commands. Note that the configurations by software commands are stored in the battery-backed SRAM that is powered through VBACKUP pin. Once it drains out, the default/factory settings will be applied.

Due to the transmitting capacity per second of the current baud rate, GNSS module has to be changed to higher baud rate for high update rate of position fix. The user can use the following software commands to change baud rate.

| Baud rate | Software command |
|---|---|
| Factory default | $PMTK251,0*28<CR><LF> |
| 4800 | $PMTK251,4800*14<CR><LF> |
| 9600 | $PMTK251,9600*17<CR><LF> |
| 19200 | $PMTK251,19200*22<CR><LF> |
| 38400 | $PMTK251,38400*27<CR><LF> |
| 57600 | $PMTK251,57600*2C<CR><LF> |
| 115200 | $PMTK251,115200*1F<CR><LF> |

Note: <CR> means Carriage Return, i.e. 0x0D in hexadecimal. <LF> means Line Feed, i.e. 0x0A in hexadecimal.

If the user does not want to change baud rate, you can reduce the output NMEA sentences by the following software commands.

| NMEA sentence | Software command |
|---|---|
| Factory default | $PMTK314,-1*04<CR><LF> |
| Only GLL at 1Hz | $PMTK314,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0*29<CR><LF> |
| Only RMC at 1Hz | $PMTK314,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0*29<CR><LF> |
| Only VTG at 1Hz | $PMTK314,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0*29<CR><LF> |
| Only GGA at 1Hz | $PMTK314,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0*29<CR><LF> |
| Only GSA at 1Hz | $PMTK314,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0*29<CR><LF> |
| Only GSV at 1Hz | $PMTK314,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0*29<CR><LF> |
| Only ZDA at 1Hz | $PMTK314,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0*29<CR><LF> |
| RMC, GGA, GSA at 1Hz and GSV at 0.2Hz | $PMTK314,0,1,0,1,1,5,0,0,0,0,0,0,0,0,0,0,0,0,0*2C<CR><LF> |
| If the command is correct and executed, GNSS module will output message | |

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$PMTK001,314,3*36<CR><LF>

After the GNSS module is changed to higher baud rate or reduced NMEA sentence, the user can configure it to high update rate of position fix by the following commands.

| Interval of position fix | Software command |
|---|---|
| Every 100ms (10Hz)[1] | $PMTK220,100*2F<CR><LF> |
| Every 200ms (5Hz) | $PMTK220,200*2C<CR><LF> |
| Every 500ms (2Hz) | $PMTK220,500*2B<CR><LF> |
| Every 1000ms (1Hz) | $PMTK220,1000*1F<CR><LF> |
| Every 2000ms (0.5Hz)[2] | $PMTK220,2000*1C<CR><LF> |
| If the command is correct and executed, GNSS module will output message $PMTK001,220,3*30<CR><LF> | |

Note 1: The minimum interval of position fix is 100ms, i.e. the maximum update rate is 10Hz.

Note 2: The current consumption is the same with the update rate of 1Hz.

## 5.6 Configure the static navigation parameter

The output position of GNSS module will keep the same and output speed will be zero if the actual speed is below the threshold of the static navigation parameter. This is useful for different applications. For example, the car stopped at a red light will get stationary GNSS position if the threshold is 1.5m/s. It is better to disable this function by setting threshold to 0 for pedestrian navigation.

The format of the software command is as below.

$PMTK386,speed threshold*checksum<CR><LF>

The unit of speed threshold is meter per second. The range of speed threshold is from 0.1m/s to 2.0m/s. Value 0 is to disable the function.

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```
Start
        │
        ▼
Change static navigation to
1.5m/s threshold
```

unsigned char SpeedThreshold1_5[] =
{"$PMTK386,1.5*39\x0D\x0A"};

GPS module will return message
"$PMTK001,386,3*3D\x0D\x0A"
if command is accepted.

Disable static navigation function?  — Yes →

Set 0 threshold

unsigned char SpeedThreshold0[] =
{"$PMTK386,0*23\x0D\x0A"};

GPS module will return message
"$PMTK001,386,3*3D\x0D\x0A"
if command is accepted.

No

End

## 5.7  Receive NMEA data through I2C interface

I2C slave address is 0x10. I2C TX buffer of GNSS module has 255 bytes. Master can read one I2C data packet maximum 255 bytes at a time. In order to read entire NMEA packet of one second, master needs to read several I2C data packets and extract valid NMEA data from them.

After reading one I2C data packet, master needs to sleep 5ms to read next I2C data packet because GNSS module spends 5ms to upload new I2C data into its I2C buffer.

### 5.7.1  I2C data packet format in slave buffer

I2C data packet in slave buffer has 254 valid NMEA bytes at most and one end character <LF>, so master must read maximum 255 bytes as an I2C data packet at a time. When slave buffer is empty, master will read one I2C data packet with all garbage byte, i.e. <LF>.

Packet format in slave buffer:

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Valid NMEA data, less than or equal to 254 bytes — End character <LF>
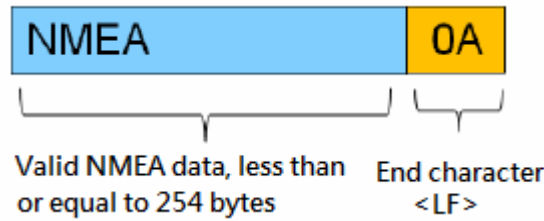
Example:

There are 254 valid NMEA bytes and 1 end character <LF> in I2C slave buffer as follwing figure.



End char <LF>

5.7.2   Three types of I2C packet that master may read

I.   When slave buffer already has some data, master read one I2C packet (255 bytes). It includes some valid data in the header of packet and some garbage bytes in the end of packet.



One I2C packet, total 255 bytes
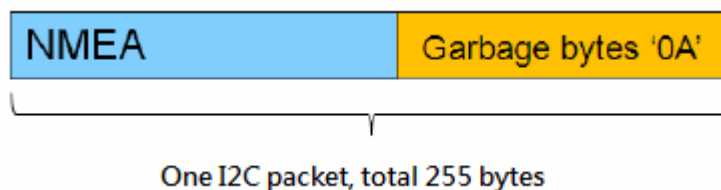
Example:

If slave buffer has 202 bytes NMEA data, master reads one I2C packet (255 bytes), the read packet format is as following.

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Note: Why garbage byte is '0A'? Because if I2C slave buffer is empty, GNSS module will output last valid byte repeatedly until new data upload into I2C buffer, '0A' is the last valid byte in the last NMEA packet.

II. When slave buffer is empty, master read one I2C packet (255 bytes). All data in packet are gargabe bytes.



Example:



III. If slave buffer is empty, master start to read one I2C packet (will read garbage bytes

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in the beginning). When this reading procedure is not over, master will read valid N



One IC packet, total 255 bytes

Example:



## 5.8 Write command through I2C interface

User can input MTK proprietary message through I2C bus. The maximum input bytes of one I2C packet is 255. The time interval of two input I2C packets can't be less than 30 milliseconds because GNSS module needs 30 milliseconds to process input data.
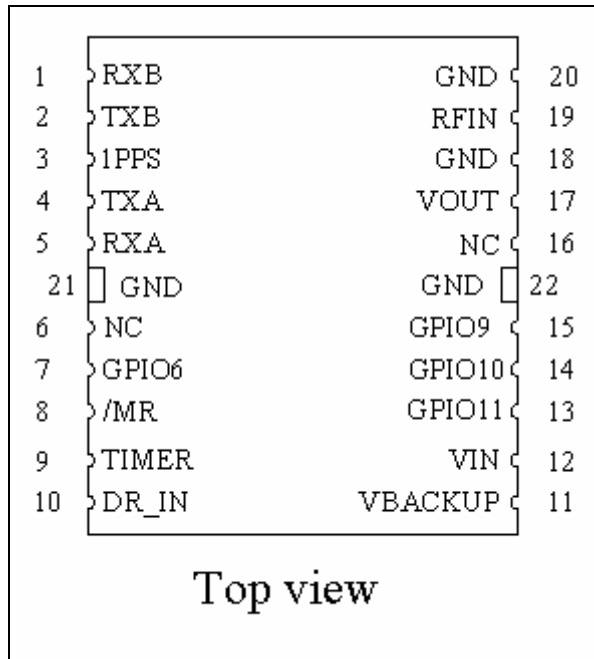


Packet length
<= 255 Bytes

Timer interval
>=30ms

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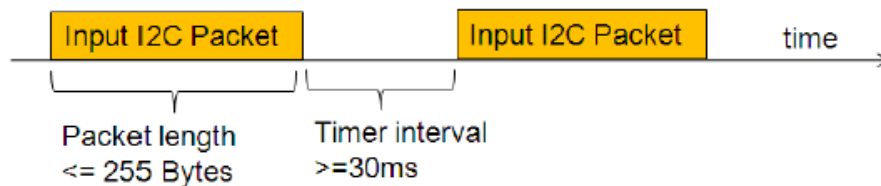
# 6 Pin assignment and descriptions



Table 6-1 Pin descriptions

| Pin # | Name | Type | Description | Note |
|---|---|---|---|---|
| 1 | RXB I2C_SCL | I | Serial input for channel B, or NMEA I2C_SCL | 1 |
| 2 | TXB I2C_SDA | O/I | Serial output for channel B, or NMEA_I2C_SDA | 1 |
| 3 | 1PPS | O | Pulse per second (default 100 ms pulse/sec when 3D fix is available) | |
| 4 | TXA | O | Serial output for channel A (Default NMEA) | |
| 5 | RXA | I | Serial input for channel A (Default NMEA) | |
| 6 | NC | | Not connect | |
| 7 | GPIO6 | I/O | General purpose I/O (Default status indicator. When GNSS position fix is available, it outputs 50ms high per second, otherwise it outputs low.) | |
| 8 | /MR | I | Manual reset input pin. Active at "L" input. Internal pulled up via a resistor. If /MR pin is not necessary, open this node. | |
| 9 | FORCE_ON | I | Logic high to force power on the module. Internal pulled up. For standard firmware, open this node. | |
| 10 | DR_IN | I | Wakeup signal input from such a G sensor. Internal pulled down. If this pin is not necessary, open this node. Note: this function is default disabled. | |

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| 11 | VBACKUP | P | Backup battery supply voltage **This pin must be powered to enable the module.** | 2 |
|----|---------|---|------------------------------------------------------------------------------------|---|
| 12 | VIN | P | DC supply voltage | |
| 13 | GPIO11 | I/O | General purpose I/O | |
| 14 | GPIO10 | I/O | General purpose I/O | |
| 15 | GPIO9 | I/O | General purpose I/O | |
| 16 | NC | | Not connect | |
| 17 | VOUT | P | Linear regulator power output, 2.8V (Do not use this as power source of backup battery) | |
| 18 | GND | P | Ground | |
| 19 | RFIN | I | GNSS RF signal input | |
| 20 | GND | P | Ground | |
| 21 | GND | P | Ground | |
| 22 | GND | P | Ground | |

<Note>

1. Work on I2C slave mode with slave address 0x10. The bit rate is up to 400K bit/s. I2C function is default disabled. Please contact us to enable it.

2. In order to get the advantage of hybrid ephemeris prediction, this pin must be always powered during the period of effective ephemeris prediction.

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# 7  DC & Temperature characteristics

## 7.1  Absolute maximum ratings

| Parameter | Symbol | Ratings | Units |
|---|---|---|---|
| Input Voltage | VIN | 4.3 | V |
| Input Backup Battery Voltage | VBACKUP | 4.3 | V |
| 2.8V Output Current | Iout | 50 | mA |
| Operating Temperature Range | Topr | -40 ~ 85 | ℃ |
| Storage Temperature Range | Tstg | -40 ~ 85 | ℃ |

## 7.2  DC Electrical characteristics

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Input Voltage | VIN | | 3.0 | 3.3 | 4.3 | V |
| Input Backup Battery Voltage | VBACKUP | | 2.0 | | 4.3 | V |
| VOUT Output Voltage | VOUT | | 2.7 | 2.8 | 2.9 | V |
| Supply Current | Iss | VCC = 3.3V, w/o active antenna, Peak Acquisition Tracking Standby | | 24 $16^{(2)}$ 365 | $150^{(1)}$ | mA mA mA uA |
| Backup Battery Current | Ibat | VIN = 0V | | 7 | | uA |
| VOUT Output Current | Iout | VIN = 3.3V | | | 30 | mA |
| High Level Input Voltage | $V_{IH}$ | | 2.0 | | 3.6 | V |
| Low Level Input Voltage | $V_{IL}$ | | -0.3 | | 0.8 | V |
| High Level Input Current | $I_{IH}$ | no pull-up or down | -1 | | 1 | uA |
| Low Level Input Current | $I_{IL}$ | no pull-up or down | -1 | | 1 | uA |
| High Level Output Voltage | $V_{OH}$ | | 2.4 | | 3.3 | V |
| Low Level Output Voltage | $V_{OL}$ | | | | 0.4 | V |
| High Level Output Current | $I_{OH}$ | | | 2 | | mA |
| Low Level Output Current | $I_{OL}$ | | | 2 | | mA |
| Minimum Pulse Width | $T_{MPW}$ | For /MR pin | 1 | | | mS |

Note 1. This happens when downloading AGPS data to MC-1513-G.

Note 2. Measured when position fix (1Hz) is available, input voltage is 3.3V and the function of self-generated ephemeris prediction is inactive. For different input voltage, the current consumption is as below chart. This is because MC-1513 is built-in DC/DC converter.
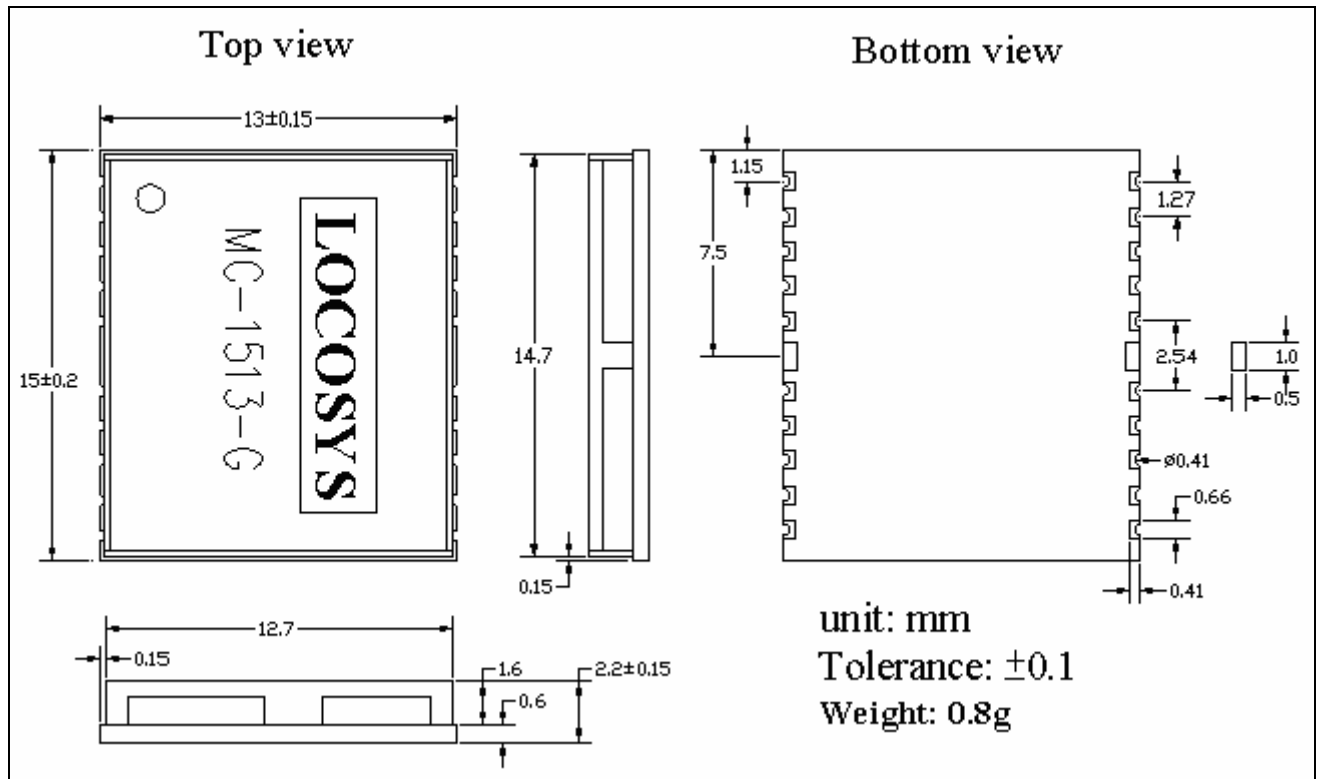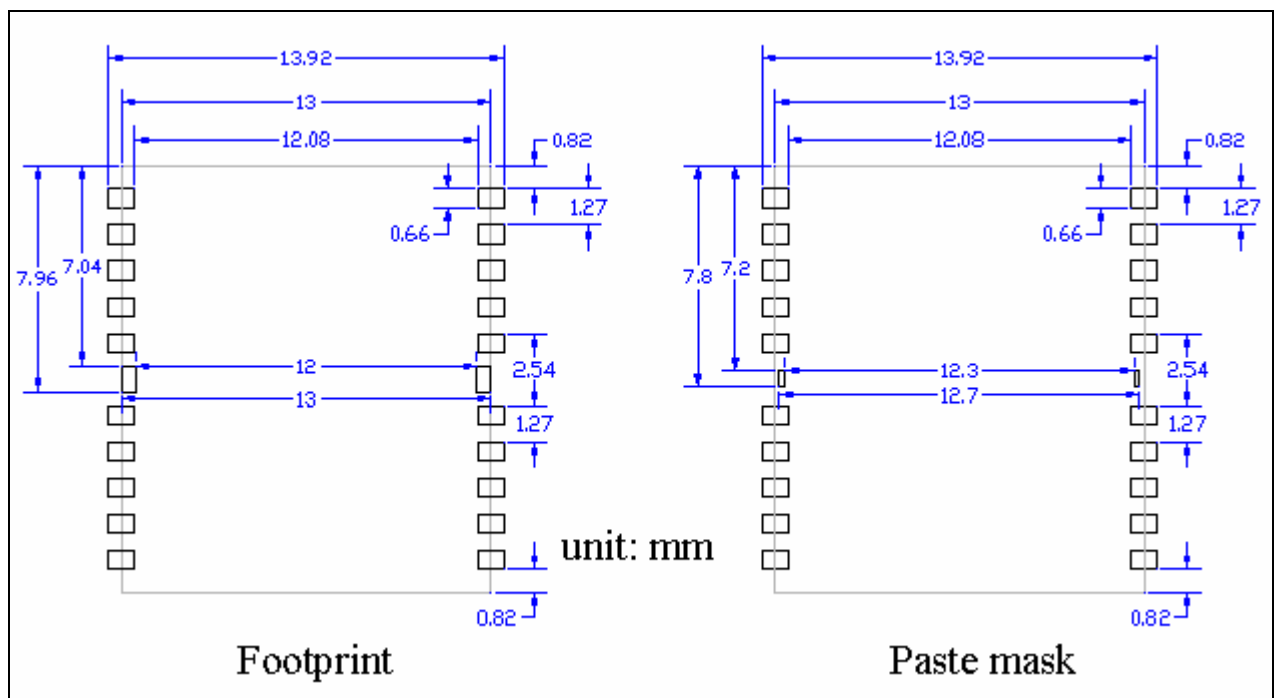
Input voltage (VIN) vs. current (Iss)
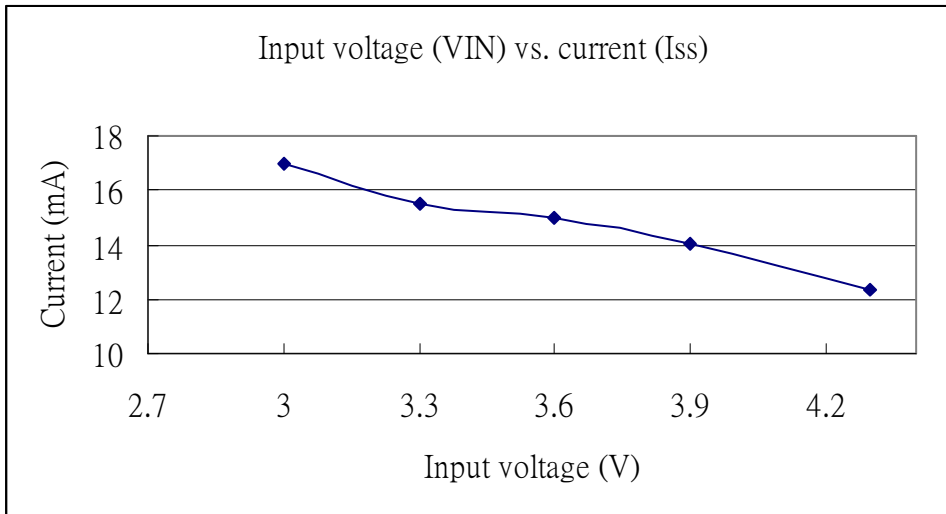


## 7.3 Temperature characteristics

| Parameter | Symbol | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Operating Temperature | Topr | -40 | - | 85 | ℃ |
| Storage Temperature | Tstg | -40 | 25 | 85 | ℃ |

# 8 Mechanical specification

## 8.1 Outline dimensions



## 8.2 Recommended land pattern dimensions

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# 9    Reel Packing information



| ITEM | DIM | ALTERNATE |
|------|-----|-----------|
| A0 | $13.5^{+0.10}_{-0.10}$ | |
| B0 | $15.5^{+0.10}_{-0.10}$ | |
| K0 | $2.5^{+0.10}_{-0.10}$ | |

SECTION A-A

SECTION B-B
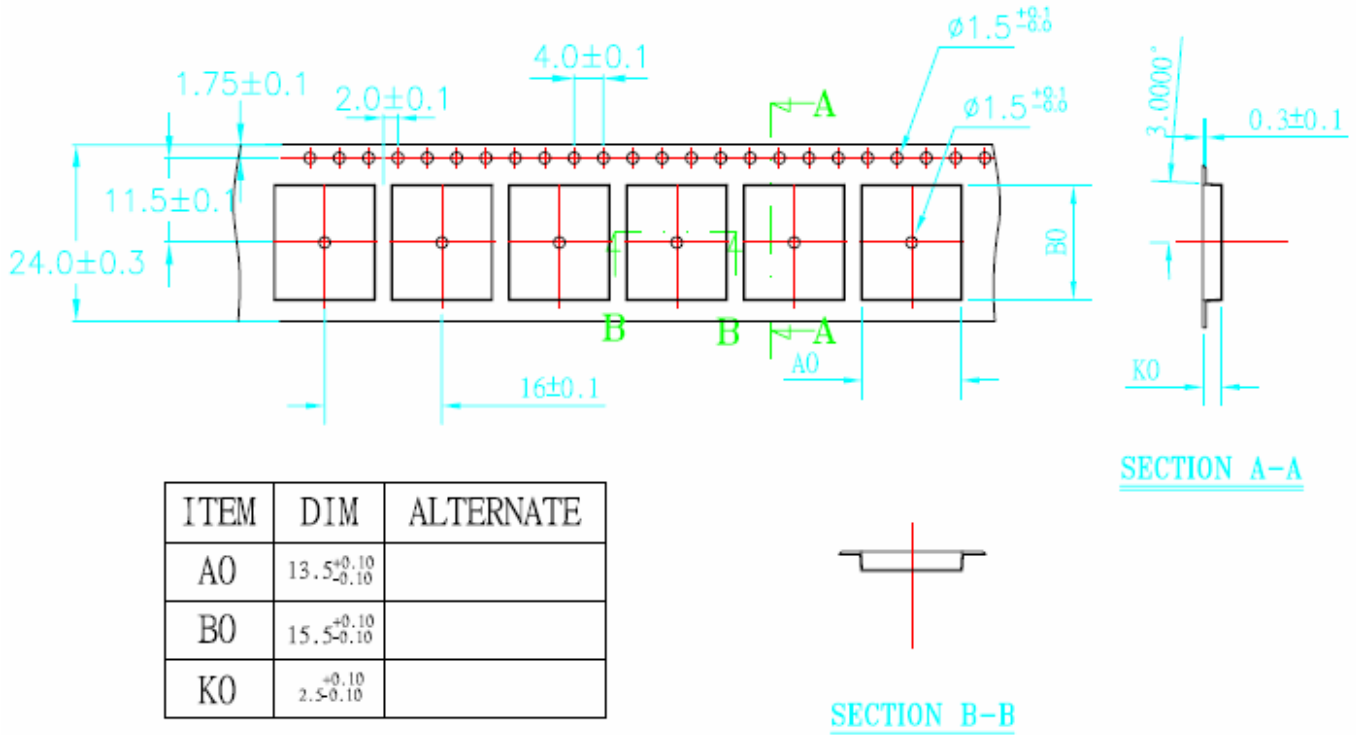
1. 10 sprocket hole pitch cumulative tolerance ±0.20mm.
2. Carrier camber not to exceed 1mm in 100mm.
3. A0 and B0 measured on a plane 0.3mm above the bottom of the pocket.
4. K0 measured from a plane on the inside bottom of the pocket to the top surface of the carrier.
5. All dimensions meet EIA-481-2 requirements.
6. Material: Black Anti-Static Polystyrene.
7. Component load per 13" reel :1000 pcs.

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# Document change list

Revision 1.0
- First release on Dec. 20, 2012.

Revision 1.0 to Revision 1.1 (March 10, 2014)
- Added I2C interface.
- Added Fig 3-5
- Added section 5.7 and 5.8.